NSWC Carderock Answers the Call to Protect Marine Life

Surface Warfare Center Commissions New Ballast Water Research Laboratory

THE NAVY COMMISSIONED a new Ballast Water Research Laboratory at the Naval Surface Warfare Center, Carderock Division to address and study the transport of aquatic nuisance species associated with ballast water.

Traveling across the globe from port to port, the U.S. Navy fleet transports Sailors and Marines, aircraft and supplies. Unfortunately, ships can also unintentionally transport stowaways, small organisms that are pulled into ballast water. Most people would not look at small organisms like mitten crabs or zebra mussels and think they are a major threat to the environment—and in their natural habitats they pose no threat. But what happens when these organisms are introduced into a new ecosystem?

According to Rachel Jacobs, a chemical engineer in the Wastewater Management Branch at the Naval Surface Warfare Center, Carderock Division, the results of introducing non-native species into a new environment can be disastrous for the ecosystem, for industry and for the marine life that already inhabit that environment. These small creatures, as well as many other organisms, can be transported through a vessel's intake and release of ballast water from one body of water to another.

Ballast water is taken in by a ship to maintain its position in the water using sea valves or pumps. The ship's stability depends on ballast water being taken in or discharged when cargo is loaded or unloaded, when the ship is traveling into different depths of water, or to adjust trim or list.

From an environmental standpoint, the problem with ballast water is that it is a means to transport aquatic nuisance species. To address and study this issue, Carderock commissioned a brand-new Ballast Water Research Laboratory on December 5, 2016 at its headquarters in West Bethesda, Maryland.

Through the use of the new laboratory, engineers and scientists at Carderock will be able to study ways to treat ballast water so that by the time ballast water is discharged at a ship's final destination, those organisms that lurk in the water will not be released to live and damage the ecosystem. The new laboratory gives researchers the capability to replicate the salinity and sediment profile of any body of water in the world. Jacobs is also looking forward to the addition of the nursery, which will give researchers the ability to grow and culture their own organisms.

"The issue of introducing non-indigenous species via ballast water has come more to the forefront internationally these days due to the

The problem with ballast water is that it is a means to transport aquatic nuisance species.

Naval Surface Warfare Center, Carderock Division Commanding Officer Capt. Mark Vandroff (right) and Technical Director Dr. Tim Arcano officially open the Ballast Water Research Laboratory on December 5, 2016 in West Bethesda, Maryland.

Monica McCoy

incredible environmental and economic repercussions that have occurred," Jacobs said. "Ships can transport a lot of organisms in ballast water because what you're doing is bringing in thousands—sometimes millions—of gallons of ballast water onto a ship, and you're delivering them to a new locale when you go to your next port of call.

"It's the sort of situation where you had power plants being horrendously impacted by zebra mussels; you had total biological ecosystems being devastated in California with mitten crabs; and in the Chesapeake Bay we've had the rapa whelk attacking oysters, which are one of the big economic drivers for Maryland and the watermen."

Jacobs, a graduate of the University of Maryland with degrees in chemical engineering and marine biology and a master's degree in environmental engineering from Johns Hopkins University, is a member of the team that facilitated the designing of the Ballast Water Research Laboratory. She and Toby Cole, a chemical engineer who was a team member and is now the deputy division head of Carderock's Environment and Energy Division, were the principal investigators for the project laboratory under the auspices of branch head Stephan Verosto, also a researcher on Navy ballast tank designs.

"There's been an incredible global push for years to reduce the introductions of aquatic nuisance species that has been headed up by the International Maritime Organization; and that's how parameters were developed for ballast water treatment," Jacobs said.

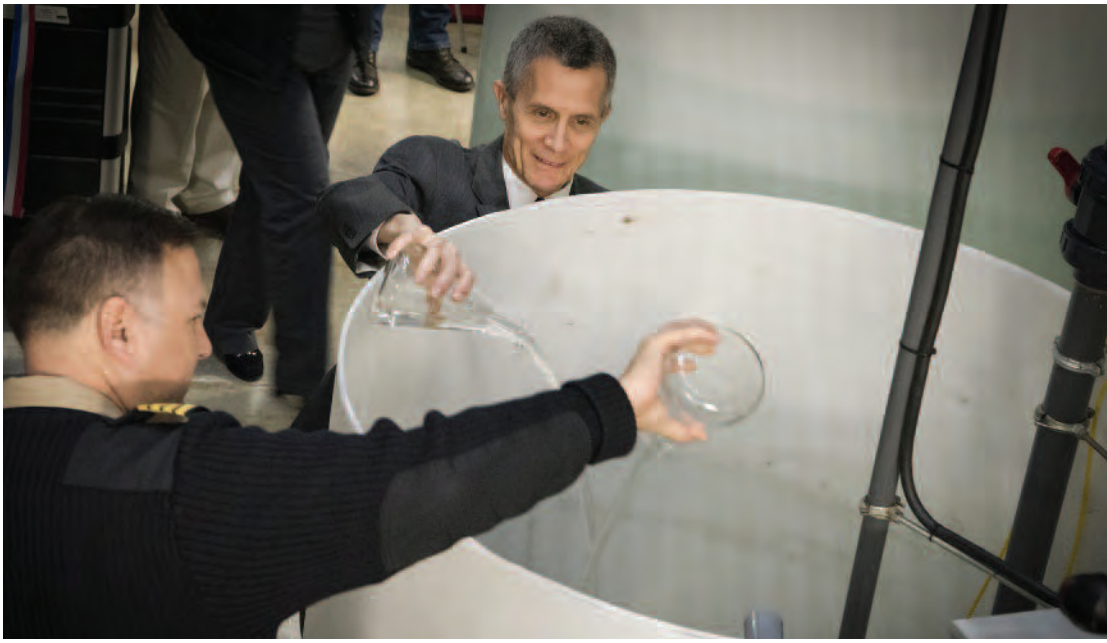
The Ballast Water Research Laboratory's setup spans two levels. Water is pumped from the salt-control tank and the sediment-control tanks on the ground floor to the mix tank on the mezzanine level. Eventually, the nursery tanks will be housed on the mezzanine level where organisms can be added in the mix tank and then fed into systems under evaluation. Engineers and scientists can then test the status of the organisms and other parameters in a sample tank on the ground floor.

"We are working with the [Carderock] Naval Architecture and Engineering Department using virtual computational fluid dynamics to actually see how water flows within specific ballast tanks in specific ship classes. We will be able to take that and then turn that into physical scaled models and test those models in the laboratory," Jacobs said.

Carderock Director of Research Dr. Jack Price committed the funds for the laboratory—which was four years in the making—after a proposal modeled from a concept Jacobs and the wastewater management team

were able to come up with in just over 24 hours. "The need and enthusiasm for such a laboratory was evident," Price said.

"There was a lot of research that was involved in doing the computational fluid dynamics calculations by our hydrodynamics people," Price said. "There's also all the parts that the wastewater management folks were bringing to bear in the knowledge of the types of species you're going to want to deal with, what their densities are, sizes and weights, etc. So it's a complicated problem, and I think we built a unique laboratory to appropriately simulate that.



Capt. Mark Vandroff (left) and Dr. Tim Arcano pour Potomac River water into a tank as part of the grand opening of Carderock's new Ballast Water Research Laboratory.
Monica McCoy

"With the fact the laboratory consists of lightweight Nalgene, or plastic tanks, you can set the laboratory up in new configurations if you have to so you can simulate the different configurations you might encounter in different ship classes. That makes it an easy module-type approach so that we can do good, accurate testing."

The Carderock Commanding Officer Capt. Mark Vandroff and Technical Director Dr. Tim Arcano commissioned the Ballast Water Research Laboratory in a ribbon-cutting ceremony by pouring water from the Chesapeake Bay into one of tanks.

"I am extremely proud to have a Ballast Water Research Laboratory here at Carderock because this is good for the environment," Vandroff said. "With our ships going all over the world, we have to be able to comply with such environmental demands or we're not going to have the access we need to fulfill our mission. The addition of this laboratory is really going to enhance our fleet."

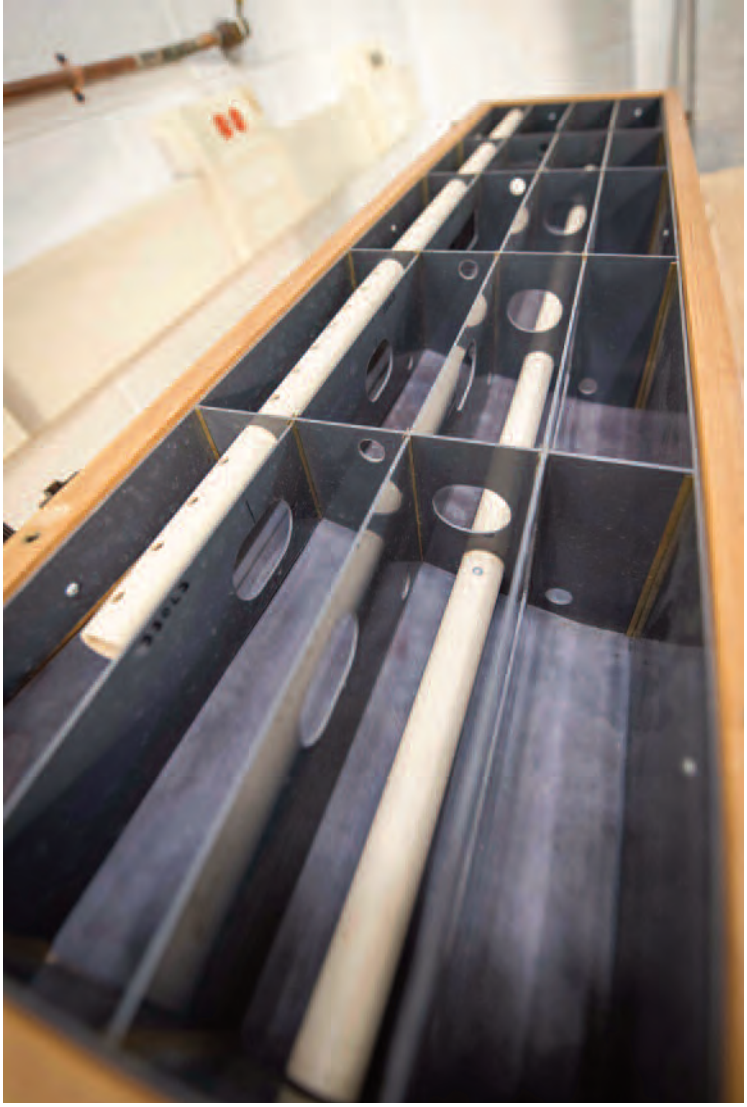
According to Rita Schuh, the Ballast Water Management Technical Area Leader and environmental engineer in the Wastewater Management Branch, the new Ballast Water Research Laboratory will provide tools necessary to continue to study and innovate ways of treating ballast water and meeting various regulations.

"Unlike major commercial transport ships that have dedicated transit lanes, the U.S. Navy goes all over the ocean,"

The Basics About Carderock

NAVAL SURFACE WARFARE Center, Carderock Division, a part of the Naval Sea Systems Command, leads the Navy in hull, mechanical and electrical engineering. Headquartered in West Bethesda, Maryland, Carderock Division employs approximately 2,000 scientists, engineers, technicians and support personnel and includes detachments in:

- Bangor, Washington
- Bayview, Idaho
- Fort Lauderdale, Florida
- Ketchikan, Alaska
- Memphis, Tennessee
- Norfolk, Virginia (Little Creek)
- Port Canaveral, Florida



An Arleigh Burke compensated ballast tank model (5-300) on display at Carderock's newly-commissioned Ballast Water Research Laboratory.
Monica McCoy

Schuh said. "Navy vessels are not always going to be in the same kind of water in the same part of the world and are not held to the same limitations. So we need to be able to ballast everywhere—in all conditions, all salinities and all temperatures. It is important to find a really robust treatment of ballast water that doesn't limit our operations."

According to Jacobs and Schuh, different treatment options have been tested in the past, but the goal is to come up with a way to ensure that no live organisms are being dumped into bodies of water to interfere with the ecosystem of native species.

"Ultraviolet radiation (UV) is one set of treatment technology that has been tested, although there have been issues in terms of how effective it is at killing the organisms versus deactivating. The whole point of UV is to basically inactivate the DNA in the organism so it's unable to replicate. It's not an official kill as compared to an inactivation, but then we have to figure out how to test for that," Jacobs said. "There are other treatment technologies in terms of chlorine dioxide and deoxygenation and all sorts of different things that have the potentiality for use."

An underside view of the Ballast Water Research Laboratory's upper test platform.
Monica McCoy

Schuh and Jacobs said they are glad to have a facility like the Ballast Water Research Laboratory that provides them the versatility to do proper testing of ballast water solutions, and they are enthusiastic about the opportunity to do their part to help protect the environment by solving the problems associated with the transport of ballast water.

Daniel Daglis
Naval Surface Warfare Center
Carderock Division
301-227-1146
DSN: 287-1146
daniel.daglis.ctr@navy.mil